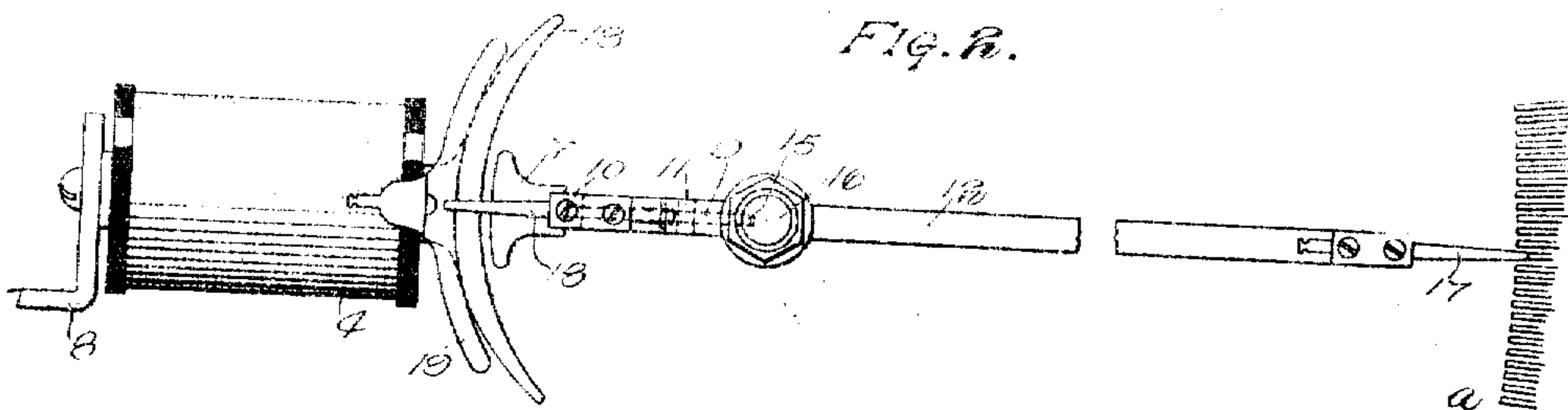
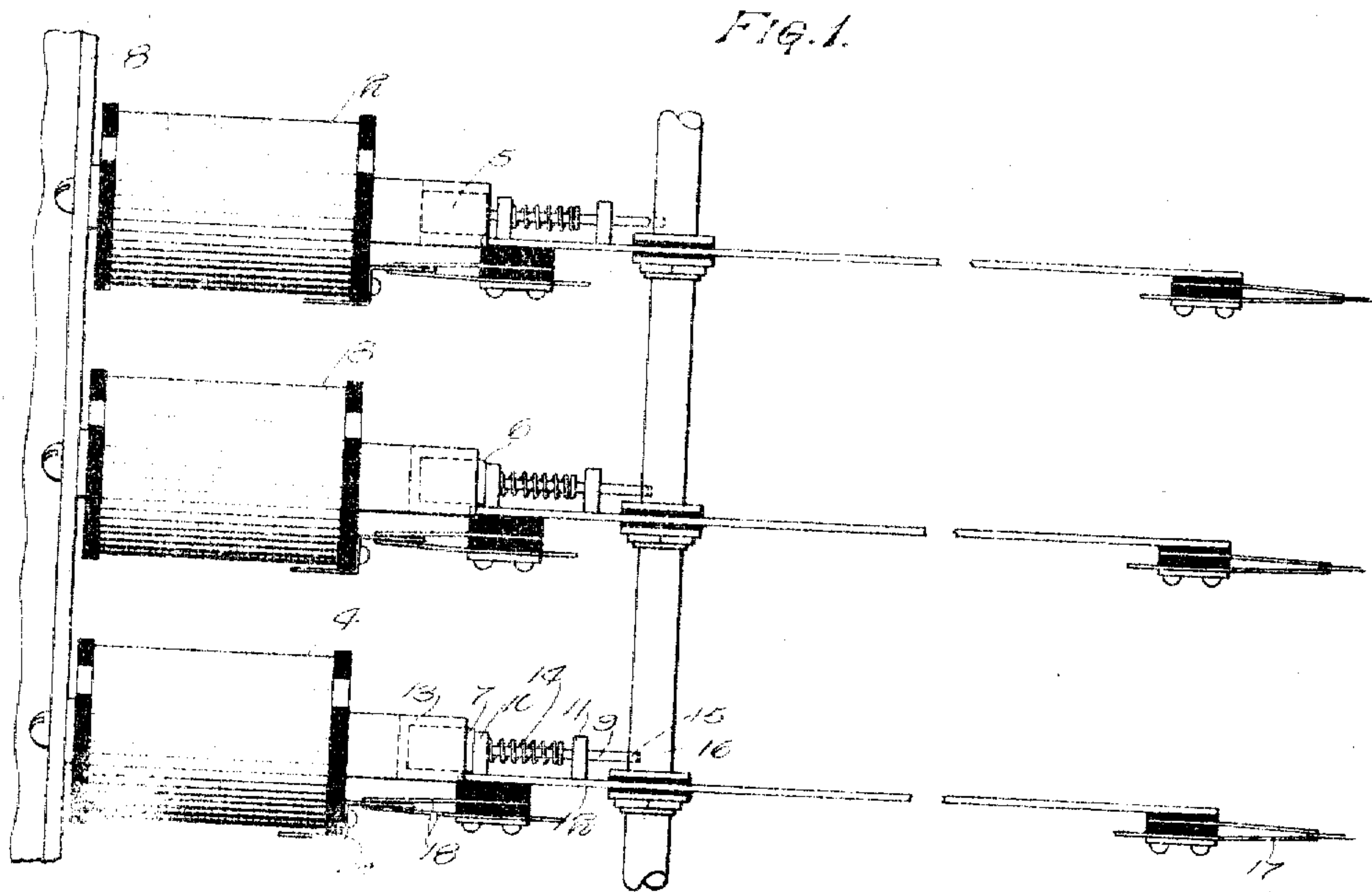


B. D. WILLIS.
TELEPHONE SWITCHING APPARATUS.
APPLICATION FILED MAR. 27, 1911.

1,134,933.

Patented Apr. 6, 1915.
2 SHEETS—SHEET 1.



WITNESSES

A. J. Ray
A. Andersen.

INVENTOR:
Bernard D. Willis
By Bulley & Sonard
ATTORNEYS

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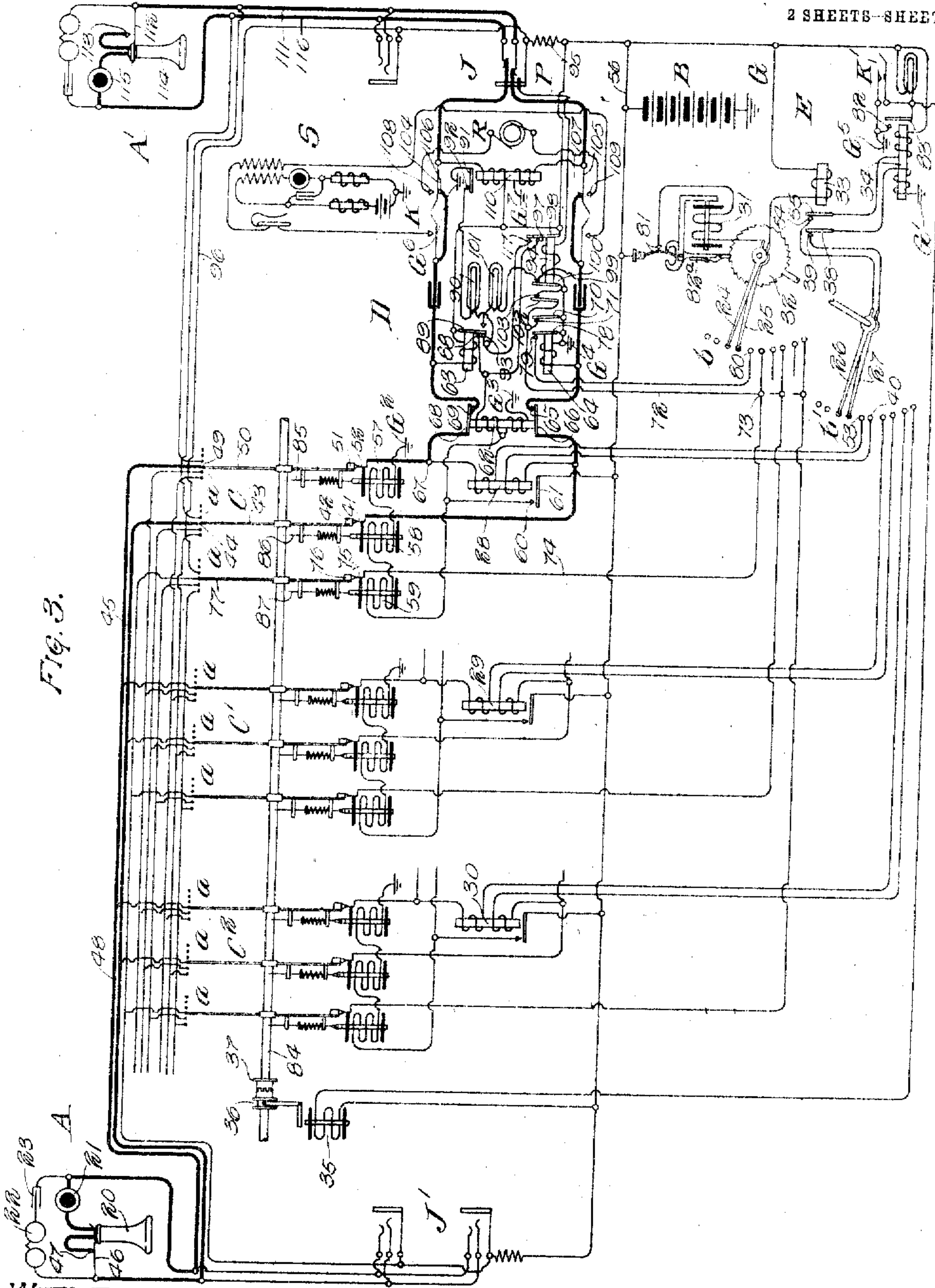


Fig. 3.

WITNESSES
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UNITED STATES PATENT OFFICE.

BERNARD D. WILLIS, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SWITCHING APPARATUS.

1,134,933.

Specification of Letters Patent.

Patented Apr. 6, 1915.

Application filed March 27, 1911. Serial No. 617,027.

To all whom it may concern:

Be it known that I, BERNARD D. WILLIS, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Telephone Switching Apparatus, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to systems employing automatic switches, and especially to semi-automatic systems.

Generally stated, the object of my invention is to provide an improved construction and circuit arrangement for automatically extending connection from a calling telephone line.

A special object is to provide an improved system of this kind in which the said connection from the calling line is established through the medium of a switch that, when idle or not in use for talking purposes, is always in motion and thus constantly searching for a calling line, and in which provision is made for automatically stopping the said switch as soon as it finds a calling line, whereby the cord and plug that is allotted to the said switch is automatically placed in connection with the calling line, the said cord having a signal by which the fact that a subscriber is calling is indicated to the operator at whose position the said cord and plug are located, thus simplifying the apparatus and the method of extending the call.

Another object is to provide a system of this kind in which there are a plurality of said automatic finder switches, with a cord and plug or other suitable connection for each switch, and in which a master switch or other suitable mechanism is provided for successively controlling the said switches, whereby only one finder switch at a time is operative to automatically stop on a calling line, the said master switch serving automatically to select another finder switch each time a switch of this kind is stopped and temporarily appropriated for use by a calling subscriber in extending the call.

It is also an object to provide certain details and features of improvement and novel combinations tending to increase the general efficiency and serviceability of a telephone exchange system of this particular character.

To the foregoing and other useful ends,

my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings, Figure 1 shows in detail a side elevation of my improved finder switch. Fig. 2 is a view showing the lower side of one of the electromagnets shown in Fig. 1. Fig. 3 represents diagrammatically a complete circuit connection established between a calling manual substation A and a called manual substation A' in a system embodying the principles of my invention.

The apparatus shown in Fig. 1 comprises what will be herein known as a finder switch. It consists essentially of three operating magnets 2, 3 and 4, mounted upon the frame 8, and their respective armatures 5, 6 and 7. Referring to Fig. 2, it will be seen that the end of the cores of each of the magnets is made to form an arc of a circle, thus allowing the armature 7 to be attracted directly toward that portion of the core in front of which it may be standing when the magnet 4 is energized. For convenience, only one of the magnets (the magnet 4, for example), with its corresponding armature, will be described, it being understood that the remaining ones are constructed and mounted in a manner similar to the one described. The armature 7 which is to be attracted by the magnet 4 is securely fastened to the outer end of the pin 9, which is loosely mounted in the uprights 10 and 11 on the end of the arm 12, and is normally held away from the core 13 of the magnet 4 due to the tension of the coil spring 14. The pin 9 is adapted, when in the proper position, to engage the opening 15 in the shaft 16. The arm 12 is loosely mounted upon the shaft 16. The outer end of the arm 12 carries a wiper 17 adapted to pass over a row of contacts *a*. The inner end, besides carrying the armature 7, also carries a wiper 18 which is adapted to engage the circular contact 19, which is mounted on the electromagnet 4. The shaft 16 is given a reciprocating motion by some external source of power, so that when the pin 9 engages the opening 15 in the shaft 16 the wiper 17 is moved back and forth over the row of contacts *a*. The wiper 18 is also moved back and forth, but is not moved out of engagement with the contact 19. The wipers 17 and 18 are connected with each other by means of a wire. Thus it will be

seen that when the electromagnet 4 is energized, it operates against the tension of the spring 14 to move the pin 9 from the opening in the shaft 16, thus allowing the arm 12 to remain in an energized position, with the wiper 17 resting on one of the contacts of the group of contacts *a*.

The manual substation shown in Fig. 3 may be of any suitable or approved type. The one shown at A, for example, comprises the usual receiver 20, transmitter 21, bells 22 and condenser 23.

The organization of the system as shown herein is as follows: The subscribers' lines are divided into groups. The lines of each group are connected to the bank contacts of a plurality of finder switches, the rotating arms of which are mounted upon a common shaft—that is, for each group of lines there is a group of finder switches less in number than the number of lines in the group. In Fig. 3 there are shown three switches C, C' and C'' of a group, together with a portion of their bank contacts. The bank contacts are shown rotated through an angle of ninety degrees from their true position, so as to indicate more clearly the manner in which the lines are connected thereto. To each finder switch there is allotted an operator's cord D terminating in a plug P. The subscribers' lines are also provided with multiple jacks, as shown at J and J'.

At E a so-called master switch is shown which is common to the group of cords of which the cord D is a member. The master switch E, through the medium of the wipers 24, 25, 26 and 27 and banks *b* and *b'*, controls the circuits of the double-wound relays 28, 29 and 30 which are individual to the finder switches C, C' and C'', respectively.

The master switch consists essentially of the motor magnet 31 for controlling the ratchet wheel 32, which is securely mounted upon the same shaft with the wipers 24 and 25, and 26 and 27. The master switch also comprises the two circuit-controlling relays 33 and 34.

The stop magnet 35 operates to disconnect the clutch 36 from its intermeshing clutch 37. When the magnet 35 is energized, the clutch 36 disengages the clutch 37, thereby allowing the shaft upon which the wipers of the finder switches are mounted to remain stationary.

At B a battery is shown with its positive terminal preferably grounded at G. At S an operator's talking set is shown.

Having given a general description of the apparatus used in the foregoing invention, I will now describe the operations brought about when the subscriber at one substation A calls and makes connection with another subscriber, the subscriber at substation A', for example.

The subscriber at substation A, upon removing the receiver from the hook, connects the two sides of his line together through the talking bridge. As soon thereafter as the wipers of the finder switches pass over the bank terminals of his line, a circuit is closed through the double-wound relay 28, which is individual to the finder switch C—that is, assuming that the wipers 24, 25, 26 and 27 are resting upon the contacts of a trunk line leading to the double-wound relay 28. This circuit through the double-wound relay 28 extends from ground G' through the left-hand winding of the relay 34, armature 38, contact 39, wiper 27, bank contact 40, lower winding of the relay 28, contact 41, wiper 42, wiper 43, contact 44, line conductor 45, switch hook 46, contact 47, receiver 20, transmitter 21, line conductor 48, contact 49, wiper 50, wiper 51, contact 52, upper winding of the relay 28, master switch bank contact 53, wiper 26, contact 54, armature 55, thence through the right-hand winding of the relay 34 to the battery lead 56, and through battery B to ground G. The relay 28 energizes upon the closure of this circuit and closes a circuit through the two line magnets and private magnet of the finder switch C. This circuit extends from ground G' through the line magnet 57, line magnet 58, private magnet 59, contact point 60, armature 61 to the battery lead 56, thence through battery B to ground G. At the same time the relay 34 operates to close a circuit from ground G' through the contact 82, armature 83 and stop magnet 35 to the battery lead 56. The magnet 35, upon energizing, disconnects the driving power from the shaft 84, allowing it to momentarily come to rest, while at the same time the magnets 57, 58 and 59 operate to withdraw the pins 85, 86 and 87 from their respective openings in the shaft 84, thereby disconnecting the arms 50, 43 and 77 therefrom and allowing them to come to rest upon the contacts of the line A. The energization of the relay 28 also closes an energizing circuit through the double-wound relay 62. This circuit extends from ground G' through the lower winding of the relay 62, contact point 60, armature 61 to the battery lead 56. The energization of the relay 62 closes an energizing circuit through the line relays 63 and 64 of the cord circuit D. This circuit extends from ground G' through the relay 64, contact point 65, armature 66, thence over the circuit previously traced to and through the substation A, back over the circuit previously traced to the point 67, thence through the armature 68, contact point 69, line relay 63 to the battery lead 56. The relay 64, upon energizing, closes the circuit extending from ground G' through the armature 70, contact point 71, conductor 72 to the point 73. One

branch leads from the point 73 over the conductor 74, contact 75, wiper 76 and wiper 77 to the private contacts of the calling line in the banks of all finder switches which have access to the calling line. Another branch leads from the point 73 through the wiper 25, cut-off relay 33 to the battery lead 56. The energization of the relay 64 also closes the circuit extending from ground G^4 through the armature 78, contact point 79, master switch bank contact 80, wiper 24, motor magnet 31, interrupter springs 81 to the battery lead 56. The motor magnet 31, upon energizing, operates to rotate the ratchet wheel 32 one step. The rotation of the ratchet wheel one step moves the wipers 24, 25, 26 and 27 out of engagement with the contacts upon which they were standing and into engagement with the next succeeding contacts, which, as before explained, are terminals of lines leading to a double-wound relay similar to those shown at 28, 29 and 30. Since the circuit of the motor magnet 31 includes the interrupter springs 81, the motor magnet, upon energizing, breaks its own circuit. Therefore, as soon as the shaft is rotated one step the armature 82^a returns to normal position, which again supplies battery current to the motor magnet 31. Assuming that the contacts upon which the wipers 24, 25, 26 and 27 are rotated are idle, the motor magnet 31 will remain deenergized. If, however, the contacts upon which the said wipers are rotated are busy, the wipers 24 and 25 will find the corresponding contacts grounded, thereby again closing a circuit through the relays 33 and 31, which will again operate to rotate the ratchet wheel 32 another step. Thus it will be seen that as long as the wipers 24 and 25 come in contact with grounded bank contacts, the master switch will continue to operate.

The energization of the relay 33, mentioned above, opens the circuit of the relay 34, which deenergizes and breaks the circuit of the stop magnet 35. Thus it will be seen that the energization of the stop magnet 35 is only momentary, long enough, however, to allow the pins 85, 86 and 87 to be withdrawn from the shaft 84. After the master switch has operated, the circuit of the relay 34 is broken at the wipers 26 and 27. Consequently, the relay 35 remains deenergized and the shaft continues to operate to carry the wipers of the idle finder switch over their bank contacts. Should it be desired for any reason to permanently stop the shaft 84, the key K' is thrown, thus closing the circuit from ground G^5 through the key K' and the magnet 35 to battery. Before the circuit of the relay 28 is broken by the rotation of the master switch wipers 26 and 27, a new circuit is completed through the magnets 57, 58 and 59 and the upper wind-

ing of the relay 62 in series. This circuit is closed upon the energization of the relay 63 and extends from ground G^2 through the magnets 57, 58 and 59, upper winding of the relay 62, contact 88 and armature 89 to the battery lead 56. It will be seen that the lower winding of the relay 62 is in multiple with the magnets 57, 58 and 59. The magnets 57, 58 and 59, as well as the relay 62, remain energized over the circuit just traced, and operate to hold the pins 85, 86 and 87 out of engagement with the shaft 84. Thus the wipers 50, 43 and 77 are allowed to remain stationary upon their corresponding contacts. The energization of the relay 63 also closes a circuit through the lamp 90. This circuit extends from ground G^6 through the armature 91, contact point 92, lamp 90, contact point 93 and armature 89 to the battery lead 56. The glowing of the lamp 90 signifies to the operator that a calling party desires a connection. Upon seeing the lamp 90 lighted the operator operates the key K to connect her talking set S with the lines of the calling station. Upon learning the number desired she inserts the plug P into the jack J . The insertion of the plug P into the jack J completes the connection between the calling substation A and the called substation A' . The insertion of the plug P into the jack J also closes an energizing circuit through the relay 94. This circuit extends from ground G^4 through the relay 94, sleeve of the plug P and jack J and resistance 95 to the battery lead 56. A circuit also extends from the sleeve of the jack J over the conductor 96 to the private bank contacts of the called line in the banks of all the finder switches which has access to said line. The relay 94 energizes in series with the resistance 95 and supplies a new holding circuit for the relay 62 by the closure of the contacts 97 and 98. The engagement of the springs 99 and 100 supplies ground to the lamp 101. The engagement of the springs 102 and 103 supplies a new guarding ground to the private bank contacts of the calling line. After inserting the plug P into the jack J , the operator throws the key K in the proper direction to shift the springs 104 and 105 out of engagement with the springs 106 and 107 and into engagement with the springs 108 and 109, respectively. The disengagement of the springs 104 and 106, and 105 and 107 disconnects the calling line from the plug P . The engagement of the springs 104 and 108, and 105 and 109 closes a ringing current from the generator R onto the line of the called subscriber. After ringing the called subscriber the operator again places the key K in normal position, which allows the two substations to be again connected. The called subscriber, upon hearing the call signal, removes the receiver from the hook. The removal of the receiver from

the hook at the called station closes the circuit through the double-wound relay 110. This circuit extends from ground G' through the lower winding of the relay 110, ring of the plug P and jack J, line conductor 111, switch hook 112, contact 113, receiver 114, transmitter 115, line conductor 116, tip of the jack J, plug P and upper winding of the relay 110 to the battery lead 56. The relay 110 energizes over the circuit just traced to disconnect ground from the lamp 90 by the disengagement of the springs 91 and 92. The called subscriber receives talking battery current over the circuit just traced, while the calling subscriber receives talking battery current through the line relays 63 and 64. The calling and called subscribers may now carry on an uninterrupted conversation over the connection as completed. The hanging up of the receiver at the called substation allows the relay 110 to deenergize, which again closes the circuit of the lamp 90. The hanging up of the receiver at the calling substation breaks the circuit of the line relays 63 and 64. The relay 63, upon deenergizing, closes the circuit of the lamp 101, the relay 94 being in an energized position. The battery is supplied to the lamp 90 after the deenergization of the relay 63 from the spring 117 on the relay 94. Thus it will be seen that the hanging up of the receiver at the calling and called substations causes the lamps 90 and 101 to glow, which signifies to the operator that the connection is ready to be taken down. The operator thereupon removes the plug P from the jack J, which causes the deenergization of the relay 94. The relay 94, upon deenergizing, opens the circuit of the lamps 90 and 101, removes the guarding ground from the private bank contacts of the calling line and breaks the circuit of the relay 62 and magnets 57, 58 and 59. The deenergization of the relay 62 disconnects the finder switch from the cord. The deenergization of the magnets 57, 58 and 59 allows the pins 85, 86 and 87 to again return into engagement with the shaft 84. Had the called line been busy the operator would have received a click by tapping the tip of the plug onto the sleeve of the jack in the usual manner.

In the foregoing description it has been explained that when two lines are connected the contacts of both lines in the private or test banks of the finder switches are provided with a ground potential. This is to prevent the finder switches from stopping on busy lines. This is accomplished as follows: Suppose that while the wipers of the master switch are resting on the contacts belonging to the switch C, the wipers of the switches engage the contacts of a busy line. guarded contact of said line the guarding At the instant the wiper 77 engages the

ground potential is extended over the conductor 74, wiper 25 and through the cut-off relay 33 to battery. The relay 33 energizes and opens the connection between the relays 28 and 34, thus preventing them from energizing and causing the switch C to connect with the busy line. In order to accomplish this result the wiper 77 may be arranged to close the circuit of the relay 33 an instant before the line wipers 43 and 50 engage their contacts.

Thus it will be seen that I provide an improved semi-automatic telephone exchange system in which constantly operating finder switches are provided and in which the telephone lines have multiple contacts over which the switches, when idle or not in use for talking purposes, are always moving in a search for calling lines. In one sense, therefore, the idle cords and plugs which are individual to these switches are always looking for calling telephone lines—that is to say, whenever a cord and plug is idle it is, through the medium of its finder switch, constantly searching for a calling telephone line. Each cord consists of a pair of voice-current conductors, and for each pair of conductors there is a battery bridge, the bridges of the different finder switches being successively controlled by the master switch. In this way only one finder switch at a time is in condition to automatically stop on a calling line. The master switch immediately selects another finder switch whenever the particular finder switch that was waiting for a call is stopped and temporarily appropriated by a calling subscriber for extending the call. Thus the stopping circuit of only one finder switch at a time is closed, the others being open, whereby the finder switches are successively brought into condition to pick up the next call. In this way the apparatus and the method of calling are much simplified.

What I claim as my invention is:—

1. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for keeping said switches in motion, magnets for automatically stopping a switch on a calling line, mechanism for controlling said switches, and a pair of voice-current conductors for each switch adapted to be connected to calling lines by the said switches, said mechanism comprising a master switch operative to automatically select another finder switch each time a switch is taken by a calling subscriber.

2. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for keeping said switches in motion, magnets for automatically stopping a switch on a calling line, mechanism for controlling said switches, and a pair of voice-current con-

ductors for each switch adapted to be connected to calling lines by the said switches, said mechanism comprising a master switch whereby only one switch at a time is in condition to stop on a calling line.

3. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for keeping said switches in motion, magnets for automatically stopping a switch on a calling line, mechanism for controlling said switches, a pair of voice-current conductors for each switch adapted to be connected to calling lines by the said switches, a battery bridge for each pair of conductors, which bridges are successively closed by said mechanism, and relays in said bridges for controlling said magnets.

4. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for keeping said switches in motion, magnets for automatically stopping a switch on a calling line, mechanism for controlling said switches, a pair of voice-current conductors for each switch adapted to be connected to calling lines by the said switches, a battery bridge for each pair of conductors, which bridges are successively closed by said mechanism, and relays in said bridges for controlling said magnets, the battery of said bridges supplying current to calling lines for talking purposes.

5. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for keeping said switches in motion, magnets for automatically stopping a switch on a calling line, mechanism for controlling said switches, a pair of voice-current conductors for each switch adapted to be connected to calling lines by the said switches, multiple jacks for said lines, and cord plugs for said conductors, which plugs are insertible in multiple jacks of called lines.

6. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, normal connections between the said lines and said contacts, devices for keeping said switches in motion, magnets for automatically stopping a switch on a calling line, mechanism for controlling said switches, a pair of voice-current conductors for each switch adapted to be rubbed over the contacts of successive calling lines and be connected to one of said lines by the said switches, condensers in said conductors, and battery bridges at opposite sides of said condensers for supplying talking current to calling and called lines.

7. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for keeping said switches in motion, magnets

for automatically stopping a switch on a calling line, mechanism for controlling said switches, a pair of voice-current conductors for each switch adapted to be connected to calling lines by the said switches, and a battery bridge for each pair of conductors, said bridges being successively controlled by said mechanism.

8. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, devices for moving said switches over said contacts, magnets for automatically stopping a switch on a calling line, a pair of voice-current conductors for each switch adapted to be connected with calling lines by said switches, and means for preventing said switches from stopping on a line which is in use, a common driver and means for stopping said driver each time a connection is extended.

9. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, and a master switch for controlling the operation of said finder switches to bring said switches successively into operation to connect with a calling line in response to a plurality of successive calls.

10. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, each of said finder switches comprising an operating magnet having an arc-shaped pole-piece, a pivoted arm carrying an armature mounted adjacent said pole-piece and carrying a contact adapted to pass over said multiple contacts, means for oscillating said arm, and means for stopping said arm by energizing said magnet to connect said switch with one of said lines.

11. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, each of said finder switches comprising an operating magnet, a pivoted arm carrying an armature mounted adjacent said magnet, means for oscillating said arm, said arm carrying a contact adapted to rub over said multiple contacts during said oscillation, means for stopping said arm by energizing said magnet to establish a circuit for talking with one of said lines, said circuit including said contact and one of said multiple contacts, and a master switch for successively bringing a plurality of said switches into operation.

12. In a telephone system, telephone lines, a plurality of finder switches in which said lines have multiple contacts, each of said switches comprising an operating magnet, an arm having an armature mounted adjacent the pole-piece of said magnet, an oscillating shaft carrying said arm, a contact carried by said arm adapted to engage with said multiple contacts, and means for ener-

gizing said magnet to disconnect said arm from said shaft to connect said switch with one of said lines.

13. In a telephone system, telephone lines, 5 a plurality of finder switches in which said lines have multiple contacts, each of said switches comprising an operating magnet, an arm having an armature mounted adjacent the pole-piece of said magnet, an oscillating shaft carrying said arm, a contact 10 carried by said arm adapted to engage with said multiple contacts, means for energizing said magnet to disconnect said arm from said shaft to connect said switch with one 15 of said lines, and a master switch for successively bringing a plurality of said switches into operation.

14. In a telephone system, telephone lines, 20 a plurality of finder switches in which said lines have multiple contacts, each of said finder switches comprising an operating magnet and a pivoted arm carrying wipers adapted to rub over said multiple contacts and adapted to be included in a talking 25 circuit, a master switch with which said wipers are adapted to be operatively connected, and means for disconnecting said wipers from said master switch.

15. In a telephone system, telephone lines, 30 a plurality of finder switches in which said lines have multiple contacts, each of said finder switches comprising an operating magnet, a pivoted arm carrying an armature mounted adjacent said magnet and 35 carrying a wiper adapted to rub over said multiple contacts and adapted to be included in a talking circuit, a master switch

with which said wipers are adapted to be operatively connected, means controlled by said master switch for oscillating said 40 wipers, and means controlled by said operating magnet for disconnecting the corresponding wiper from the master switch.

16. In a telephone system, lines, terminals for said lines, switches for connecting 45 with said lines via said terminals, automatic means for maintaining each switch in motion while no switching operations are occurring, a magnet for each one of said switches and an automatic common 50 device for controlling the circuits of said magnets to bring their corresponding switches into use for connecting with the said lines if idle.

17. In a telephone system, telephone lines, 55 a plurality of finder switches in which said lines have multiple contacts, each of said finder switches comprising an operating magnet having an arc-shaped pole-piece, a pivoted arm carrying an armature mounted 60 adjacent said pole-piece and carrying a contact adapted to pass over said multiple contacts, means for oscillating said arm, means for stopping said arm by energizing said magnet to connect said switch with one of 65 said lines, and a master switch for preselecting the next finder switch to be brought into operation.

Signed by me at Chicago, Cook county Illinois, this 16th day of March, 1911.

BERNARD D. WILLIS.

Witnesses:

ARTHUR J. RAY,
E. D. FALES.

It is hereby certified that in Letters Patent No. 1,134,933, granted April 6, 1915, upon the application of Bernard D. Willis, of Chicago, Illinois, for an improvement in "Telephone Switching Apparatus," errors appear in the printed specification requiring correction as follows: Page 3, line 104, for the word "has" read *have*; page 4, lines 64 and 65 should be transposed; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of May, A. D., 1915.

[SEAL.]

R. F. WHITEHEAD,
Acting Commissioner of Patents.